10/594404
IAP01 Rec'd PCT/PTO 26 SEP 2006

TESTING INTEGRATED CIRCUITS

The present invention relates to a method of testing integrated circuits and in particular to a method of testing integrated circuits which incorporate radiation sensing elements.

Integrated circuits may be tested by being inserted into a test socket, the test socket providing temporary electrical connections to the integrated circuit and applying suitable voltages, signals, loads, or monitors to the various connections. If the integrated circuit incorporates a sensing element, the testing may also include applying a suitable stimulus to the sensing element and monitoring the output voltages, signals or loads of the integrated circuit. If the sensing element is a radiation sensing element such as an optical sensor, the suitable stimulus is a controlled exposure to radiation.

Testing of this sort typically takes place after the integrated circuit has been packaged in a protective housing. The integrated circuits are picked up individually and inserted into the test socket by a test handler and retained in position, in the test socket by a plunger, the plunger applying pressure to the non contact side of the package.

Radiation sensing integrated circuits such as those adapted to detect visible or infra red radiation are housed in a package having a transparent opening or window by means of which such radiation may enter the package. When such packages are tested in the manner described above, if the radiation sensing capability is to be tested then it is necessary to expose the sensor to radiation through the window. If the

package is very small then it is difficult to specifically adapt the plunger so that it does not cover the glass window and thus preclude testing of the radiation sensing capability of the packaged integrated circuit.

After the completing the testing of an individual packaged integrated circuit, the plunger releases the package and moves away. The tested package is then removed from the test socket by the test handler and a new integrated circuit is then inserted into the socket. The plunger then moves in towards the new package to retain it in position for testing. The time taken to change between packages is called the index time and is typically less than 500 milliseconds. Due to the amount of movement made by the plunger during this time interval, and the resultant acceleration experienced by the plunger, it is not feasible to mount any testing electronics or any suitable radiation source on the plunger.

It is thus an object of the present invention to provide an apparatus and method of testing packaged radiation sensing integrated circuits which overcomes or alleviates the above problems.

According to a first aspect of the present invention there is provided an apparatus for testing a packaged integrated circuit of the type incorporating a radiation sensing element comprising: a load board provided with electrical circuitry for interfacing with the packaged integrated circuit to be tested; a test socket, said test socket being mounted on said load board and being adapted to provide electrical connections between said packaged integrated circuit and said load board; a plunger for retaining said packaged integrated circuit within said test socket; and a radiation source mounted on said load board adjacent to said test socket wherein a radiation

pathway is provided in said plunger, said pathway directing radiation emitted by said radiation source through said plunger to the radiation sensing element of said packaged integrated circuit.

According to a second aspect of the present invention there is provided a method of testing packaged integrated circuits of the type incorporating a radiation sensing element comprising the following steps: inserting said packaged integrated circuit into a test socket, said test socket being mounted on a load board and being adapted to provide electrical connections between said packaged integrated circuit and said load board wherein said load board is provided with electrical circuitry for interfacing with the packaged integrated circuit to be tested; retaining the packaged integrated circuit in the test socket by applying pressure with a plunger; and directing radiation from a radiation source mounted on said load board adjacent to said test socket through a radiation pathway provided in said plunger, thereby exposing the radiation sensing element to a suitable radiation signal emitted by the radiation emitting means.

In this manner, there is provided an apparatus and a method by which a packaged radiation sensing integrated circuit can be exposed to a controlled quantity of radiation for testing purposes. Furthermore the method and apparatus is capable of being applied to conventional handing equipment with only minor modifications and is capable of dealing with small packaged radiation sensing integrated circuits.

Preferably, the radiation pathway is a generally U-shaped pathway through the plunger. Preferably a first end of the pathway is adjacent to the radiation source and a second end of the pathway is adjacent to the sensing element of the packaged

integrated circuit when the plunger is used to retain the packaged integrated circuit within the test socket. Most preferably, said pathway is adapted for directing radiation from one end to its other end by the provision of radiation directing means.

In one preferred embodiment, the radiation directing means comprises two or more prisms mounted within the pathway. In an alternative preferred implementation the radiation directing means comprises one or more preferably a bundle of collimated optical fibres mounted within the pathway.

Preferably the radiation source is operative to emit a radiation pattern which is directed to the radiation sensing element of the packaged integrated circuit via the pathway. The radiation pattern may comprise variation in the intensity or frequency of radiation emitted by the radiation source either spatially or temporally. Most preferably, the spatial position of the radiation pattern on the light source can be varied to compensate for minor misalignment between the plunger, the radiation source and the packaged integrated circuit.

Preferably the area of the radiation source is equal to or greater than the cross-sectional area of the pathway. Preferably, the cross-sectional area of the pathway is greater than or equal to the area of the sensing element of the packaged integrated circuit. Most preferably, the shape of the radiation source, cross-section of the pathway and the sensing element of the packaged integrated circuit are similar.

In order that the invention is more clearly understood, it will now be described further herein, by way of example only and with reference to the following drawings in which:

Figure 1 shows a section through a conventional testing apparatus;

Figure 2 shows a testing apparatus in accordance with a first embodiment of the present invention; and

Figure 3 shows a testing apparatus in accordance with a second embodiment of the present invention.

Referring now to figure 1, a conventional testing apparatus or test engine for a packaged integrated circuit comprises a load board 101 carrying a test socket 102 suitable for use with the particular packaged integrated circuit under test or device under test (DUT) 103. The DUT 103 is pushed into and retained in the socket 102 by pressure from a plunger 104. After completion of the desired tests on DUT 103, the plunger is retracted to allow the DUT 103 to be removed from the test socket and replaced by a new DUT 103. The plunger 104 is then extended once more to push the new DUT 103 into test socket 102. In this way, the apparatus can be used to test a succession of DUTs 103.

The load board 101 comprises circuitry adapted to interface with standard connections on the test socket 102 to test the specific requirements of the DUT 103. The load board 101 is specifically adapted to the DUT 103, and stores and runs device specific testing software. To reduce costs, and the time taken to change a testing apparatus from testing a first design of device to a second design of device, all the device specific aspects of the testing apparatus are provided wherever possible on the load board 101 and in the testing software. In this manner, the load board is replaced when the type of device to be tested changes.

When the DUT 103 is a packaged integrated circuit incorporating a radiation sensing element such as an optical or infra red sensing element, the DUT 103 is exposed to suitable radiation in order to test the response of the sensing element to stimulus. Typically such devices comprise a window or other opening in the package allowing the passage of radiation to the sensing element.

In order to reach the sensing element of DUT 103 when in the test socket 102, radiation must travel through, past or originate from within the plunger. As typically the plunger 104 retracts and extends very quickly, it is not feasible to provide a radiation source or the necessary control circuitry for a radiation source on the plunger 104. The radiation source is thus typically provide somewhere behind the plunger 104 and the plunger 104 is adapted to provide a hole through which radiation can pass to the sensing element or some form of recessed portion allowing radiation to travel past the edge of the plunger 104 to the sensing element. This reduces the grip of plunger 104 on DUT 103 and thus means that the DUT 103 is retained less securely in the test socket 102. Additionally, this requires careful alignment of the radiation source with the plunger 104 to ensure that radiation has an unobscured path to the sensing element of the DUT 103. Furthermore, as the radiation source is relatively remote, a relatively powerful radiation source must be used. The radiation source will typically also require a suitable focussing lens arrangement to provide a collimated beam of radiation that may pass through the hole in the plunger 104 or past the edge of the plunger 104 as appropriate.

Figure 2 shows a testing apparatus or test engine according to a first embodiment of the present invention. As in the conventional testing apparatus shown

in figure 1, the testing apparatus of figure 2 comprises a load board 101, a test socket 102, suitable for the device under test (DUT) 103, and a plunger 104. Additionally in the present invention, a radiation source 107 is provided on the load board 101 adjacent to the test socket 102.

The radiation source 107 generates radiation for testing the response to stimulus of the radiation sensing element of the DUT 103. In particular, the radiation source 107 is operative to generate a spatial radiation intensity pattern for testing the response of individual portions of the sensing element. In preferred embodiments, the radiation source 107 comprises a plurality of closely spaced individual radiation sources. It is of course possible that temporal radiation intensity patterns and temporal or spatial frequency variation patterns may additionally or alternatively be used for testing. The generation of said radiation patterns is controlled by device specific application software running on the test engine.

In order to allow the sensing element of the DUT 103 to be exposed to the radiation, a pathway 108 is provided through plunger 104. The pathway 108 has a U-Shape with the end of one side of the U being adjacent to the radiation source 107 and the other end of the U being adjacent to the sensing element of DUT 103. Radiation entering the pathway 108 from the radiation source 107, travels along the U and exits the other end of the U where it is then incident upon the radiation sensing element of DUT 103.

In order to direct radiation along the pathway 108 in the manner described above, in the embodiment of figure 2, prisms 105, 106 are mounted at the base of each side of the U so as to reflect incident light along the pathway 108. If care is

taken to align the reflecting surfaces in this embodiment, the radiation incident upon the sensing element of DUT 103 is an accurate representation of the radiation pattern emitted by radiation source 107.

In order to ensure that radiation emitted from the radiation source is incident over the whole of the sensitive area of the sensing element, the radiation source 107 has an area at least as large as that of the cross-sectional area of the pathway 108 and is preferably larger. Similarly, the cross sectional area of the pathway 108 is at least as large as that of the sensing element and is preferably larger. This means that small misalignments in the position of the plunger 104 do not compromise the operation of the test apparatus. In order to operate with a misalignment, the radiation source 107 is adapted to be able to vary the spatial position of the whole or part of the radiation pattern in response to electrical signals received from the DUT 103 via the test socket 102 and load board 101.

In figure 2, the prisms 105, 106 are positioned so that they reflect radiation from an external surface. It is of course possible that the prisms 105, 106 could be repositioned so that reflection of radiation takes place from internal surfaces of the prisms 105, 106. As a further alternative, mirrors could be provided in the pathway 108 at the positions occupied by prisms 105, 106 in figure 2.

Referring now to figure 3, in an alternative embodiment, the prisms 105, 106 are omitted and the pathway 108 is filled by a bundle of collimated optical fibres 109. The number of individual optical fibres used depends on the resolution required in the radiation pattern emitted by radiation source 107 for testing and also the size of the incremental movements used to correct for minor misalignments of the plunger 104.

It is of course to be understood that the invention is not to be limited to the details of the above embodiments which are described by way of example only.